SYLLABUS

Name: ***Design and rapid prototyping of embedded control systems (AESAu-A>SI7C-DRP24)***
Name in Polish:
Name in English: ***Design and rapid prototyping of embedded control systems***

Information on course:

Course offered by department: Faculty of Automatic Control, Electronics and Computer Science
Course for department: Silesian University of Technology

Default type of course examination report:

ZAL

Language:

English

Course homepage:

https://platforma.polsl.pl/rau1/course/view.php?id=1182

Short description:

The aim of the course is to familiarize students with the basic principles of effective design and prototyping of control systems, taking into account new methods of computer-aided design, project management, modeling and rapid prototyping. A significant part of the course is dedicated to the issue of rapid prototyping methodology in MiL, SiL, PiL, and HiL structures. Students will also learn about specialized Matlab and Simulink libraries used to communicate with peripheral devices, which in turn enables rapid, real-time prototyping of control systems.
The student should have a background in: control fundamentals, robotics fundamentals, classical mechanics, basics of measurement, design of simple continuous and discrete control systems, embedded systems, programming in Matlab/Simulink and C++.

Description:

ECTS: 3
Total workload: 90 hours (65 contact hours, 25 students' own work hours)
Forms of contact hours:
Lecture 30h
Laboratory 30h
Other (e.g. test and reports revision and discussion) 5h

Lecture:
1. Introduction. CAD / CAM / CAE / PDM systems - basic information. Mechatronics.
2. Communication protocols: CAN, RS232, SPI, I2C.
3. Network infrastructure – TCP and UDP protocols.
4. Discrete-time control. Anti-windup system. Measuring and control signals. PWM control.
5. Sensors - technologies and applications.
6. Filtering and processing of measurement data– basic information.
7. Computer aided design of control systems - tools: PID Tuner, LTI Viewer, Control System Designer (SISO Tool), Control System Tuner, Stateflow.
8. Handle Graphics: GUIDE, App Designer.
9. Elements of process identification – System Identification Toolbox (IDENT).
10. Rapid prototyping of control systems.
11. Model Based Design (MBD) approach.
12. Verification and validation based on MiL, SiL, PiL, HiL models.
13. Software solutions supporting prototyping and real-time code generation. Automatic generation of controller codes directly from the CACSD environment. Real-time simulation.
14. Hardware solutions supporting prototyping. Prototyping boards. Single board industrial computers. Specialized modules using microcontrollers.

Laboratory:
The laboratory includes 6 exercises during which students become familiar with the individual stages of the design and prototyping process of the control system. Individual lab exercises are supported by consultations with lecturers. Topics of individual exercises are as follows:
1. Introduction to the CACSD environment.
2. PWM control. A/D converters.
3. Identification and modeling of DC motor dynamics.
4. Discrete-time control.
5. Rapid prototyping of the control system.
6. Anti-windup in the control system.

Bibliography:

1. Kamrani, Ali K., Nasr, Emad Abouel : Rapid Prototyping, Theory and Practice. Springer, 2006.
2. Ali K. Kamrani, Emad Abouel Nasr : Engineering Design and Rapid Prototyping. Springer, 2010.
3. Hristu-Varsakelis, Dimitrios, Levine, William: Handbook of networked and embedded control systems. Springer, 2005.
4. Li Li, Fei-Yue Wang: Advanced Motion Control and Sensing for Intelligent Vehicles. Springer, 2007.
5. Rao V. Dukkipati: Analysis and Design of Control Systems Using MATLAB. New age International Publishers, 2006.
6. Gessing R.: Control Fundamentals, Wydawnictwo Politechniki Śl., Gliwice 2004.

Learning outcomes:

Course-specific learning outcomes: at the completion of the course, student:
- know basic methods, techniques and tools used in solving simple engineering tasks in the field of automatics, robotics, electronics and computer science (test) K1A_W2, K1A_W7, K1A_W8,
- know the methods of analysis and design of embedded control systems (test) K1A_W11,
- are able to use selected tools for computer aided design and evaluation of the quality of electronic circuits, control systems and computer systems (test, laboratory report) K1A_U4, K1A_U5, K1A_U8,
- are able to build simple digital, microprocessor and embedded systems with software (laboratory report) K1A_U13, K1A_U14.

Assessment methods and assessment criteria:

Course consists of two components: lecture and laboratory. According to SUT regulation, lecture attendance is optional (however highly recommended), whereas laboratory exercises are obligatory.

Students need to pass written assessment test (T) and must complete all laboratory exercises and obtain a pass mark on all reports. Making up missed laboratory work is possible on the dates specified in the schedule. On the lecture test, students must obtain a minimum of 50% to pass. Final laboratory grade (L) is calculated as average of all report grades.
The final grade is calculated as: Grade = (0.4T + 0.6L)
The grade is rounded according to the following rules:
[3.00 - 3.25) - 3.0
[3.25 - 3.75) - 3.5
[3.75 - 4.25) - 4.0
[4.25 - 4.75) - 4.5
[4.75 - 5.00] - 5.0

The syllabus is valid from academic year 2024/25 and its content cannot be changed during the semester.

Course credits in various terms:

<without a specific program>

Type of credits	Number	First term	Last term
European Credit Transfer System (ECTS)	3	2024/2025-Z	